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The Language Grid: supporting intercultural collaboration

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A variety of language resources already exist online. Unfortunately, since many language resources have usage restrictions, it is virtually impossible for each user to negotiate with every language resource provider when combining several resources to achieve the intended purpose. To increase the accessibility and usability of language resources (dictionaries, parallel texts, part-of-speech taggers, machine translators, etc.), we proposed the *Language Grid* [1]; it wraps existing language resources as atomic services and enables users to create new services by combining the atomic services, and reduces the negotiation costs related to intellectual property rights [4]. Our slogan is “language services from language resources.” We believe that *modularization with recombination* is the key to creating a full range of customized language environments for various user communities.

The first step is to wrap each language resource as an atomic language service. Such services are not restricted to a simple function accessing the language resource. For example, the parallel text service can return a high quality translation of a sentence that is similar to the input sentence. Wrapping machine translators is straightforward, but even human interpreters can be wrapped as translation services. Users do not have to distinguish machine from human translation services other than by their quality: machine translators can provide faster services while human interpreters return high quality translations.

The second step is to combine atomic language services to create new services [2]. For example, to translate Japanese sentences into Vietnamese, we need to cascade Japanese-English and English-Vietnamese translation services, because currently there is no direct translator handling Japanese to Vietnamese. Furthermore, if we need to replace words output by machine translators with the technical words in dictionaries specific to the service domain, we can use part-of-speech taggers to divide the input sentences into parts and then identify the technical words. If we have different types of translators, then we need a service to determine which one is the best. In spite of all these efforts, if the quality of translation is still insufficient, we may then call upon human translation services. The above scenario introduces what we call the composite service workflow.

The Language Grid allows users to register services to share them. Major stakeholders in forming the service grid fall into three categories: *service providers*, *service consumers*, and *grid operators*. Service providers register language services to the service grid, while service consumers invoke registered language services as needed for their intercultural activities. Grid operators manage and control language resources and services. For the institutional design of the Language Grid, we have to consider the following contexts of the stakeholders:

- How to protect the intellectual property rights of service providers and to motivate them to register services with the service grid. To this end, service providers should be allowed to specify for what purposes their services can be used.



- How to encourage the widest variety of activities of service consumers to increase their satisfaction. To this end, service consumers should be allowed to run application systems that employ the services permitted for such use.
- How to reduce the load of grid operators while allowing them to globally extend their service grids. To this end, *federated operation* is to be facilitated, where several operators collaboratively operate their service grids by connecting them in a peer-to-peer fashion [5].

We have organized the Language Grid project based on collaboration among service providers in various universities, research institutes and for-profit companies, and service consumers in non-profit and non-governmental organizations [3]. Action research methodologies are being employed during the project. Software development, applications in real communities, and institutional design for federated operation are all related, and thus are being performed in parallel. As a result, the Language Grid has become one of the most advanced infrastructures for services computing. As of September 2017, 177 groups in 23 countries are participating by sharing 230 language services through the federated operation of Language Grid servers located in Kyoto, Jakarta, Bangkok and Xinjiang.

The Language Grid runs on the *service grid server software*, which is registered with GitHub. Note that language services are often used together application-domain-specific services: healthcare, agriculture, marketing etc. Our service grid server software is general enough to permit sharing of not only language services but also services in various domains. For example, to support patients who are using local languages, we can combine the Language Grid with a healthcare service grid. Federated operation can be applied to connect different types of service grids. We are now entering the era of IoT. Future application domains will scale the server network to adapt to the growing IoT environment. A pioneering work that analyzes such future service networks appears in [6].

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